

Minimum Receiver Requirements for Teracom and Boxer DTT Networks

(in Sweden, Finland and Denmark)

Additions and clarifications to the NorDig Unified specification
(CA System, MPEG4 AVC HDTV, DVB-T2 etc)

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1. Introduction

1.1. Scope

This document specifies the minimum receiver (technical) requirements for the Swedish, Danish and Finnish Digital Terrestrial TV (here denoted as S-DTT, D-DTT and F-DTT) network to receive Standard Definition TV (SDTV) and High Definition TV (HDTV) services. This receiver is hereafter denoted as an Integrated Receiver Decoder (IRD). The IRD shall be DVB compliant, able to receive MPEG-2 Transport Streams from a terrestrial modulated signal and to decode and de-scramble the services within.

(For the Swedish DTT this document specifies requirement for all kind of IRDs (i.e. both FTA IRDs and IRDs intended to handle scrambled services handled in embedded CAS, via Common Interface or or Common Interface Plus. For the Danish DTT and Finnish DTT this document specifies requirements for receivers intended to handle scrambled services. For pure FTA IRDs, the NorDig Unified specification is the requirement and this document can be seen as a guideline).

1.1.1. Informative Swedish DTT network status autumn 2011

The Swedish DTT (S-DTT) network includes 7 Multiplexes, 5 of them broadcasting in DVB-T system and 2 of them broadcasting in DVB-T2 system. The service bouquet within the current S-DTT network is a mixture of Free-to-Air (FTA) and scrambled services. The majority of the services within the S-DTT are normally scrambled (in total by spring 2012 approx 53 TV services within the network, where approx 45 scrambled and 8 FTA services).

The network has a mixture of MPEG2 based SDTV services, MPEG4 based SDTV services and MPEG4 HDTV services (only in DVB-T2). Some of the services are time shared and some of the services have regional content. The network broadcast both in UHF (Mux1-7) and VHF (part of Mux7) and have regional SFN areas in operation.

The S-DTT network has one CA System (Viaccess) for all scrambled services, one Pay-TV Operator (Boxer) and one Network Operator (Teracom).

1.1.2. Informative Danish DTT Network status autumn 2011

The Danish DTT (D-DTT) network includes 5 Multiplexes, all currently broadcasting in DVB-T system but one Multiplex (Mux 5) is scheduled to be converted into DVB-T2 system during spring 2012. The service bouquet is a mixture of Free-to-Air (FTA) and scrambled services. The majority of the services within the D-DTT are scrambled.

The network has a mixture of MPEG4 based SDTV services and MPEG4 HDTV services (both in DVB-T and DVB-T2). (Since January 2012 the D-DTT has no longer any MPEG2 based services). The network broadcast currently only in UHF.

The D-DTT network has one CA System (Viaccess) for all scrambled services, one Pay-TV Operator (Boxer) and one Network Operator (Teracom).

1.1.3. Informative Finnish DTT Network status autumn 2011

The Finnish DTT (F-DTT) network includes 8 Multiplexes, 4 of them broadcasting in DVB-T system and 3 broadcasting in DVB-T2 system and 1 broadcasting in DVB-H system. The one using DVB-H will be converted into DVB-T/-T2 in April 2012. The service bouquet within the current F-DTT network is a mixture of Free-to-Air (FTA) and scrambled services.

The network has a mixture of MPEG2 based SDTV services in DVB-T Muxes, MPEG4 based SDTV services and MPEG4 HDTV services in DVB-T2 Muxes. The network broadcast both in UHF (Mux A, B, C, E, F) and VHF (A,B).

Currently the F-DTT network is operated by three Network Operators (Digita, DNA and Anvia), three Pay-TV Operators (PlusTV, TV Viihde and DNA), and all of them are using Conax CA System. (Teracom Group is the majority owner of PlusTV, TDF Entertainment's service TV Viihde is part of the TDF Group, DNA is part of the DNA Group).

1.2. Document History

Version	Date	Comments
A / 1.0	2002-05-06	First final version
B / 1.0.3	2007-07-04	2nd version
C / 2.0	2008-08-08	3rd version, (incl requirement for reception of MPEG4 HDTV services)
D / 2.1	2009-12-01	4th version, with the following (main) changes from v2.0: - references to latest NorDig IRD specification (v2.1) - optional DVB-T2 reception - Common Interface Plus extensions for CI receivers - Content Protection for any external digital interfaces
2.1.1	2010-04-27	5th version, with the following (main) changes from v2.1: - exclusion of DVB CSA3 for embedded descrambling
2.3	2012-03-12	6 th version, , with the following (main) changes from v2.1.1: - chapter 3 CA, updates related to CA requirements and inclusion new chapter 3.1.3 of security related requirements for recordable IRDs. - chapter 4 Terrestrial demodulation: - new chapter 4.1.1, all new IRDs from 2013 shall support DVB-T2, - new chapter 4.1.2, support of 7 MHz DVB-T2 signals over UHF, - new chapter 4.1.3, protection against other digital signals (e.g. LTE), - new chapter 4.1.4, installation mode - chapter 5 Demux and decoding: - new chapter 5.1.1, 3DTV - new chapter 5.2.5, MPEG4 HE-AAC metadata - new chapter 5.2.6, Supplementary audio (“audio description”) - new chapter 5.2.7, Dynamic changes in audio (changes in languages) - new chapter 5.3, Teletext (without PTS and when PTS out of sync) - chapter 7 SI, new chapter 7.2.2 Preferred DVB Network - chapter 8 Receiver states and Navigator, new chapter 8.5.1 Languages (requirements to support Swedish, Danish, Finnish and English languages) - chapter 10, PVR requirements and Boxer navigator requirements (the whole section is new)
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1.3. Terminology

Mandatory / shall This word means that the item is mandatory.

Recommended / should This word means that this item is not mandatory, but is highly recommended. If included, then it shall be implemented as specified.

Optional This word means that this item is not mandatory, gives added value to different IRD implementations. But if this item is included then it shall be implemented as specified here.

1.4. List of Abbreviations

AAC	(MPEG-4) Advanced Audio Coding (ISO/IEC 14496-3) here refers to HE-AAC level 4
AC3	Dolby Digital audio coding (ETSI TS 102 366)
AC3+	Enhanced AC3, Dolby Digital Plus audio coding, (ETSI TS 102 366)
API	Application Programming Interface (for example DVB MHP)
AVC	Advanced Video Coding (MPEG-4 part 10 ISO/IEC 14496-10, ITU-T H.264)
BAT	(DVB SI) Bouquet Association Table
bslbf	bit string, left bit first
CA	Conditional Access
CAM	Conditional Access Module
CAS	Conditional Access (CA) System
CBI	Crex Boxer Infotag
CI	(DVB) Common Interface
CI+	(DVB) Common Interface Plus specification v1.2 or later
CSA	(DVB) Common Scrambling Algorithm
CSA2	CSA version 2
CSA3	CSA version 3
DTS	DTS audio (ETSI TS 102 114)
DTT	Digital Terrestrial Television
DVB-T	DVB T Terrestrial broadcast (ETSI EN 300 744)
DVB-T2	DVB T2 Terrestrial broadcast (ETSI EN 302 755)
DVB	Digital Video Broadcast
E.AC3	Enhanced AC3, Dolby Digital Plus audio coding, (ETSI TS 102 366)
EICTA	European Information & Communications Technology Industry Association, (today Digital Europe)
EIT	(DVB SI) Electronic Programme Guide
EPG	Electronic Programme Guide
EPT	(DVB-T) Effective Protection Target
ESG	(DVB SI) Event Schedule Guide
FTA	Free To Air
H.264	Same as AVC (MPEG-4 part 10 ISO/IEC 14496-10, ITU-T H.264)
HD	High Definition (TV)
HDTV	High Definition TeleVision
HE.AAC	(MPEG-4) High Efficient AAC version 1 Level 4
IRD	Integrated Receiver Decoder
LCD	(NorDig) Logical Channel Descriptor
LCN	(NorDig LCD) Logical Channel Number
LTE	Long Term Evolution (4 th generation of mobile communication network)
MFN	(DVB-T) Multiple Frequencies Network
MHP	Multimedia Home Platform (API)
Mono	Monaural audio, i.e. 1.0 channel audio stream
MPEG	Moving Picture Expert Group
Multi-channel	Multichannel audio, i.e. up to 5.1 channel audio stream (i.e. 3.0, 4.0, 5.1 etc)
n/a	Not Applicable
NID	(DVB SI) Network Identifier
NIT	(DVB SI) Network Information Table
NVOD	Near Video On Demand
ONID	(DVB SI) Original Network Identifier
OSD	On Screen Display
p/f	(DVB SI) Present / Following (event)
PCM	Pulse-Code Modulation audio (IEC 60958)
PSI	(MPEG) Programme Specific Information
QEF	(DVB-T) Quasi Error Free (reception)
sch	(DVB SI) Schedule (event)
SDT	(DVB SI) Service Description Table
S-DTT	Swedish DTT (Digital Terrestrial Television)
SDTV	Standard Definition TeleVision
SFN	(DVB-T) Single Frequency Network
SI	(DVB) Service Information
SID	(DVB SI) Service Identifier (== MPEG Program Number)
SMC	(CA) Smart Card
Stereo	Stereo (left and right) audio, 2.0 channel audio stream
TDT	(DVB SI) Time and Date Table
TOT	(DVB SI) Time Offset Table
TS	(MPEG) Transport Stream
TSID	(DVB SI) MPEG-2 Transport Stream Identifier
uimsbf	unsigned integer most significant bit first

UTC

Co-ordinated Universal Time

2. General features for a digital receiver

The requirements for IRDs (integrated receiver decoders) in the DTT network in this specification are fully based on the latest NorDig Unified receiver specifications (version 2.3 or later) and its M4 Level (i.e. incl MPEG4 and HDTV) (www.nordig.org) with some additions and clarifications included in this document (mainly CA). Teracom is an active member of NorDig and participates in NorDig's development of receiver requirements.

All IRDs shall be able to receive and decode MPEG2 SDTV based services as well as MPEG4 AVC (H.264) based SDTV and HDTV services. Swedish and Danish DTT network are using DVB Common Scrambling Algorithm based on Conditional Access System from Viaccess for scrambling of services.

When using '**IRD**' (Integrated Receiver Decoder) it refers to all types of receivers. The IRDs can be divided into the following main implementation categories and variants:

- A **STB** (Set Top Box) is an IRD which is an external unit and thus not embedded in a TV Set/Display
- An **iDTV** (integrated Digital Television Set) is an IRD which is a integrated into the TV Set/Display
- A **recordable IRD** is an IRD (STB or iDTV) with the capability to record, store recordings and/or timeshift and later play these recordings.
- A **PVR** is a recordable IRD which fulfil the PVR requirements like series recording etc (see chapter 10)
- **DVB-T IRD**, is an IRD which supports only DVB-T demodulation (and no DVB-T2 support)
- **DVB-T2 IRD**, is an IRD which supports both DVB-T2 and DVB-T demodulation

Other IRD implementations such as a PC Card (e.g. PCI) or USB/Firewire external receivers or similar, these products together with the PC are treated as an iDTV excluding the CA requirements.

Currently all IRD shall support DVB-T demodulation. Support of DVB-T2 demodulation is optional. (The requirement for DVB-T2 will be changed from optional to mandatory for all new IRD from 1st Jan 2013). If the IRD specifies support for DVB-T2, it shall support all (additional) requirements for a DVB-T2 IRD as specified in NorDig Unified IRD specification.

Table below provides a general overview of the mandatory, optional and recommended features and interfaces for the all the different categories of IRDs defined in this specification.

Overview table

IRD variant	DVB-T IRD	DVB-T2 IRD
Minimum requirements for IRD types		
DVB-T demodulation (“DVB-T1”)	M	M
DVB-T2 demodulation	-	M
UHF band IV-V and 7 MHz	O	M
UHF band IV-V and 8 MHz	M	M
VHF band III and 7 MHz raster	M	M
VHF band III and 8 MHz raster	O	O
DVB-T2, Time Frequency Slicing	-	O
DVB-T2, 1.7 MHz raster within VHF band III	-	O
CSA2, DVB Common Scrambling Algorithm version 2 (1)	M	M
DVB Common Interface (2)	M	M
Common Interface Plus (2)	M	M
Video decoding: MPEG2 MP@ML & MPEG4 AVC HP@L4	M	M
Audio decoding: MPEG1 L.II, HE.AAC (up to 5.1) & E.AC3 (up to 5.1)	M	M
Audio decoding; use of audio metadata for HE.AAC and E.AC3	M	M
Audio down-mix multichannel (5.1, 4.0, 3.0 etc) down to 2.0 (stereo)	M	M
Subtitling decoding: EBU Teletext & DVB Subtitling (up to HD)	M	M
EBU Teletext	M	M
API (like DVB MHP)	O	O
V/A Interface out: HDMI with HDCP for STB (3)	M	M
V/A Interface out: analogue TV out (like SCART) for STB (3)	O	O
Recording capability (as specified in 3.1.3)	O	O
PVR features (as specified in chapter 3.1.3 and 10 and NorDig PVR)	O	O
Boxer Navigator PVR (as specified in chapter 3.1.3 and 10.2)	O	O
De-compression of lossless compressed SI data (4)	-	O (future)
M; Mandatory, R; (Highly) Recommended, O; Optional item to include, alt; different alternatives: Note 1: requirement for CSA v2 are applicable for IRDs with built-in descrambler. Note 2: requirement for DVB CI or CI+ are applicable for IRDs with Common Interface, see chapter 3. Note 3: HDMI &/or analogue TV out is optional for iDTV. Note 4: IRD not supporting this shall be able to ignore/skip this data fields (text strings)		

Table 1 Overview technical requirements for Teracom Boxer approved IRDs

3. CA System and interfaces for the DTT Network

This chapter covers the requirement defined for DVB Descrambling for the DTT's CA System, and refers to the NorDig Unified specification chapters 4 (4.2), 9 (9.4) and 15.

3.1. Requirements in additional to NorDig specifications (chapter 4 and 15)

Used DVB Conditional Access System (CAS) in the Swedish and Danish Terrestrial TV Network is the **Viaccess** CAS which is based on the DVB Common Scrambling Algorithm (CSA). (The DTT network's CA operator is 'Boxer TV Access', here shorten to 'Boxer').

IRD may have either no CA support (pure FTA) for the DTT networks or CA support for scrambled services. IRD with CA support for DTT networks may either be via embedded CA System with SmartCard Reader or via DVB Common Interface / Common Interface Plus.

iDTV with display screen diagonal larger than 30 cm shall include at least one Common Interface.

All IRDs with Common Interface shall support Common Interface Plus extension.

Common Interface Plus extension refers to the "CI Plus Specification, Content Security Extensions to the Common Interface" version 1.2 or later.

Descrambling for IRD (CAM or embedded CAS) shall support at least DVB CSA2.

3.1.1. Embedded ViAccess CA products

For IRDs with embedded CA System, the requirements are:

- Shall support Viaccess ACS 3.0 or higher (Boxer version) shall be used. Please contact ViAccess for latest Boxer ACS.
- Shall use of Secure Chipset with Viaccess key
- The implementation shall be certified by Viaccess SA and the document "Boxer Approval Application form" shall be signed and returned to Boxer
- Shall support Boxer specific CA OSD messages (for error messages and IRD support information), contact Boxer for the time valid detail information for this
- The use of an approved Boxer logo is mandatory for use on product and packing

3.1.2. DVB common Interface CA products

For IRDs with DVB Common Interface or Common Interface Plus for CA System, the (mandatory) requirements are:

- shall be able to handle Viaccess approved secure CA Module with Viaccess CA System for:
 - CI IRD ACS 3.0 or higher and
 - CI+ IRD ACS 4.0 or higher
- shall support download of new CA system software to a CA Module via using DVB SSU.

For approved CA Modules see the Service Operators, Boxer TV Access, listed approved products, for example at www.boxer.se.

Informative; the requirements for Common Interface for iDTVs with display larger than 30 cm, follows the European Union Directives.

3.1.3. Recordable IRD

3.1.3.1. Definitions for recordable IRDs

The Recordable IRD (an IRD with recording functionality) is an IRD with possibility to record digital and playback DVB content and services distributed in DTT networks where Boxer is present. A Recordable IRD product refers to all manufactured units of the same IRD model and from same manufacture, while a Recordable IRD device refers to each manufactured unit of the *product*.

The storage of recording is be made is the Recordable IRD's recording memory. The Recordable IRD's recording memory could be on internal and/or external memory, such as HDD, flash memory, removable media (DVD, BluRay) etc, interfaced by proprietary solution, USB, eSATA, memory card-reader or any other interface. The Recordable IRD typically has PVR functionalities as described in chapter 10.

Broadcast encryption refers to the scrambling and encryption added to the broadcast content by the Operator(s) on the broadcast side before the signal is received by the IRD. Pay-TV services refers to scrambled services and content with DVB Conditional Access control broadcast encryption (DVB CSA scrambling and encryption with Boxer CAS). FTA TV (Free-to-Air) refers to services and content that is broadcasted with no scrambling or encryption.

Local encryption refers to scrambling and encryption added to the received broadcast content by the Recordable IRD. CI Plus encryption refers to local encryption added to broadcast content by the CI Plus compliant CAM. The local encryption AES refers to Advanced Encryption Standard in accordance with National Institute of Standards and Technology (NIST) as U.S. FIPS 197.

3.1.3.2. Security requirements for recordable IRD

The Recordable IRD's digital recordings shall before storage into the recording memory be re-encrypted to another format than the broadcast encryption used for broadcast purposes.

All storage (even temporary for time-shifting) in any persistent recording memory shall at all time be encrypted, stored secure and binding to the specific Recordable IRD for playback.

All data written to the recording memory shall have local encrypted using 128-bit (or higher) AES cipher using unique cipher key for every Recordable IRD device and considered to be proper security used to secure the content.

The Recordable IRD's recordings shall not to be playable on any other electronic Recordable IRD product or device, each Recordable IRD product shall support local encryption key(s) which makes each Recordable IRD device unique. A device unique number array which resides in each Recordable IRD device shall be used to build the AES key. (This mean that the local encryption based on a device unique encryption key(s) shall be such unique that the recordings cannot be decrypted/descrambled from any other Recordable IRD product or device even if it has the same decryption capabilities).

The recording memory shall not contain any information about the cipher or the key (unless encrypted with security no less than 128-bit AES) used during the encryption process.

Storage recording memory shall never be used as a scratch memory to store temporary unencrypted content as chunks of data waiting to be encrypted or cipher key used.

Timeshift content shall also be considered as record file and is written in the same encrypted format as normal recorded content.

The actual local encryption key(s) used for scrambling the recordings shall be unique for each recording memory paired with the Recordable IRD. The Recordable IRD may store several local encryption keys i.e. be paired with multiple recording memories units simultaneously as long as each recording memory is encrypted with a unique local encryption key.

If the *Recordable IRD* cannot store several *local encryption keys* to handle multiple *recording memories* this shall be clearly stated in the user manual or via pop-up message before pairing begins, informing the user that the currently paired *recording memory* will not be playable if a new *recording memory* is paired with the *Recordable IRD*.

4. Terrestrial Tuner and Demodulator

This chapter covers the requirement defined for Terrestrial Tuner and Demodulator and refers to the NorDig Unified specification chapter 3.4 with the following clarifications and additional requirements.

4.1. Additional requirements for terrestrial tuner and demodulator

A DVB-T2 IRD shall fulfil all the DVB-T2 IRD requirements specified by NorDig.

4.1.1. DVB-T2 mandatory for all new IRDs from 2013

All new IRDs from 1 January 2013 shall support both DVB-T and DVB-T2 demodulation.

4.1.2. 7 MHz DVB-T2 signals over UHF

The DVB-T2 transmissions on VHF band III can be frequency converted to UHF band IV/V for better household coverage. Because on-air DVB-T2 transmission on VHF band III has 7MHz signal bandwidth, the on-air (low power) retransmission on UHF band IV/V will have 7MHz signal bandwidth as well.

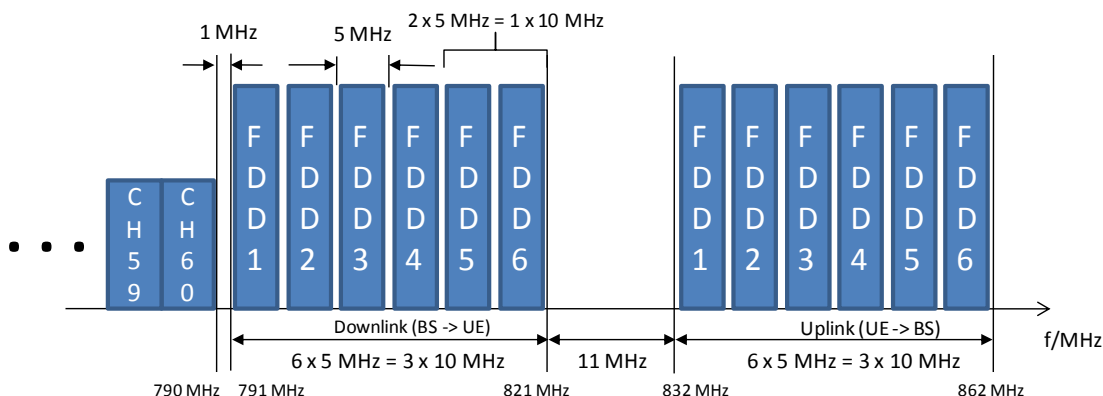
The DVB-T2 IRD shall be capable to receive 7MHz signal bandwidth DVB-T2 signals on UHF band IV/V (for 7 MHz signals using same centre frequency of as any 8 MHz signals in UHF band IV/V, see NorDig Unified Annex B.2).

The DVB-T2 IRD shall be able to receive signals with an offset of up to 50 kHz from the nominal frequency.

The DVB-T2 IRD shall have the same performance for immunity to digital signal in other channels as specified in NorDig Unified specification in chapter 3.4.10.7 when receiving DVB-T2 signals with 7 MHz signal bandwidth on UHF band IV/V.

4.1.3. Protection against other digital signal

In many European countries UHF band V channels from CH61 to CH69, corresponding frequency range from 790 MHz to 862 MHz, are or will be allocated to mobile services. (Observe that DTT Networks may broadcast DVB-T/DVB-T2 signals up to and including CH60 i.e. 782-790MHz). It is expected that mobile telephone network operators will use the LTE technology for 4G mobile telephone systems on this frequency range 790 MHz to 862 MHz. Within this frequency range, the frequency range from 791 MHz to 821 MHz is used for transmission from base station (BS) and frequency range from 832 MHz to 862 MHz is used for transmission from user equipment (UE). Allocated frequency ranges are divided into 6 x 5MHz blocks, but most common implementation is expected to use 2 x 5 MHz block and is therefore using 10 MHz system bandwidth of LTE signal. Frequency allocation is illustrated in figure below.



The DVB-T and DVB-T2 IRD shall, for the supported frequency ranges, permit an interfering 4G (LTE) signal with a minimum interference to signal level ratio (I/C) as stated in the Table 2 below while maintaining QEF reception.

The power of the LTE signal, both BS and UE, varies with a traffic load. The signal power of the LTE signal is defined as the power during the active part of the time varying LTE signal. The I/C values shall be fulfilled for traffic loads 0% to 100 % (BS) and for traffic loads from low bit rate to high bit rate (UE). Low traffic loads can be the most demanding ones.

Band	DVB-T/DVB-T2 channel	Signal Bandwidth MHz	Channel frequency raster MHz	Minimum I/C (dB)		
				10 MHz Downlink (FDD1&2)	10 MHz Downlink (FDD3&4, FDD5&6)	10 MHz Uplink (FDD1&2, FDD3&4, FDD5&6)
VHF III	K5-K12	7	7	40	40	40
UHF IV	K21-K37	8	8	40	40	40
UHF V	K38-K59	8	8	40	40	40
UHF V	K60	8	8	30	40	40

Table 2 Minimum required I/C for QEF reception with interfering LTE signal on the adjacent and other channels. I/C values are defined for LTE signals having signal bandwidth of 9.015 MHz in 10 MHz LTE system. I/C values for other signal bandwidths must be recalculated.

The requirements in this paragraph refer,

for DVB-T, to following modes {FFT size, modulation, code rate, guard interval, bandwidth};

- {FFT=8K, M=64-QAM, CR=2/3, GI =1/8, B=8MHz},
- {FFT=8K, M=64-QAM, CR=2/3, GI =1/4, B=8MHz} and
- {FFT=8K, M=64-QAM, CR=3/4, GI =1/4, B=8MHz}

and for DVB-T2 to the modes {FFT size, modulation, pilot pattern, code rate, guard interval, bandwidth}

- { FFT=32KE, M=256-QAM R, PP=4, CR=2/3, GI =1/16, 8MHz},
- { FFT=32KE, M=256-QAM R, PP=2, CR=3/4, GI =1/8, 8MHz},
- { FFT=32KE, M=256-QAM R, PP=4, CR=3/5, GI =19/256, 8MHz},
- { FFT=32KN, M=256-QAM R, PP=4, CR=2/3, GI =19/256, 7MHz} and
- { FFT=32KN, M=256-QAM R, PP=2, CR=3/4, GI =1/8, 7MHz}

FFT size 32KE refers to FFT size 32k with extended carrier mode, while 32KN refers to FFT size 32k with normal carrier mode.

Modulation 256-QAM R refers to 256 QAM with rotated constellation.

4.1.4. **Terrestrial network installation mode** (*NorDig Unified 3.4.4.4*)

Clarification, IRD shall support terrestrial network installation mode *Automatic Search, best service*, as described in NorDig Unified (chapter 3.4.4.4).

The DVB-T2 IRD shall be able to automatically and manually scan DVB-T2 7 MHz signal bandwidth signals on centre frequencies specified for UHF band IV/V in NorDig Unified Annex B.2.

5. Demultiplexing and decoding

This chapter covers the requirement defined for MPEG demultiplexing, Video, Audio, Teletext and subtitling decoding, and refers to the NorDig Unified specification chapter 4, 5, 6 and 7 with the following clarifications and additional requirements.

The IRD shall fulfil the NorDig HD Level IRD requirements as specified in the NorDig specification, which for the demultiplexing and decoding, which means following main requirements (see NorDig specification for all details).

5.1. Video

The IRD shall support video decoding for;

- MPEG2 video decoding up to Main Profile at Main Level (MP@ML) and
- MPEG4 AVC (H.264) video decoding up to High Profile at Level 4 (HDTV).

Observe specifically that this means that all IRD shall support MPEG4 SDTV services using High Profile video encoding tools, MPEG4 AVC (H.264) HP@L3. (This HP@L3 is the common usage for MPEG4 AVC video encoding of SDTV services within the Swedish DTT network).

The IRD shall support still picture for all MPEG4 AVC profiles.

5.1.1. 3DTV video handling

5.1.1.1. Background broadcast of 3DTV

As by beginning of 2012, 3DTV is not part of the regular broadcast. (3DTV or 3D refers in this document to plano-stereoscopic 3DTV, while 2DTV or 2D refers in this document to the conventional non-3DTV format). Teracom and Boxer intend to follow the DVB specification and guidelines regarding any 3DTV broadcast. The more likely scenario for any 3DTV broadcast within near future is that it will:

- be event based 3DTV within HDTV services (ie with service type 0x19)
- be frame compatible mode (according to DVB 3DTV phase 1) and
- use the broadcast format 720p50Hz Side-by-Side (SbS) (but other relevant formats are 720p50Hz Top-and-Bottom (TaB) and 1080i25Hz SbS).

(Note: Due to interoperability issues with some legacy IRDs, Teracom/Boxer do not intend to use “cropping rectangle” and “sample aspect ratio” signalling for 3DTV broadcast as mentioned in Annex B of ETSI TS 101547).

5.1.1.2. IRD requirements for 3DTV

It is optional for an IRD to be 3DTV compliant as defined in ETSI TS 101547, i.e. able to identify a frame compatible 3DTV transmission and also able to render the 3D content correctly. (ETSI TS 101547, “Frame compatible Plano-Stereoscopic 3DTV”, also available as DVB Document A154, “Frame compatible Plano-Stereoscopic 3DTV”)

However for 3DTV compliant IRDs the following requirements apply:

A 3DTV compliant IRD shall support the presentation of a 3DTV broadcast according to ETSI TS 101547 in a non-3DTV-mode (i.e. a “2DTV” mode) as well as in 3DTV mode.

A 3DTV compliant IRD shall be able to detect the transitions between 2D and 3D content.

The IRD shall not rely on signalling in EIT or SDT to detect the 2D and 3D transitions.

Indicated methods to decide whether the current video is 3DTV or 2DTV are:

Alternative 1) Use the signalling in the PMT and in the video stream: H.264/AVC Supplemental Enhancement Information (SEI).

Alternative 2) Automatic detection of content type by analysing the video.

A 3DTV compliant IRD shall support dynamic changes in the broadcast between 2DTV and 3DTV within 1 second after reception of any changes. For services dynamic changing from 2DTV to 3DTV broadcast for a 3D program event, a 3DTV IRD should as a factory default continue to present the 3DTV broadcast in a non-3DTV-mode (“2DTV”). The IRD should then prompt the viewer that a 3D event is now available for the selected service and ask the viewer for confirmation to change the presentation into a 3DTV mode. (The IRD may in its user preference setting let the user change this factory default behaviour).

It is recommended that all DVB-T2 IRD that are not 3DTV compliant be 3D cognisant as defined in ETSI TS 101547. This implies that such IRDs should at least be able to detect frame compatible plano-stereoscopic 3DTV content when it occurs, and perform a 3D-to-2D conversion to allow good 2D viewing. (The 3D to 2D conversion could be done by taking the left or the right view half of the transmitted frame compatible picture and up-scale this half to fit the entire display area).

5.2. Audio

5.2.1. Audio format decoding

The IRD shall support monaural (mono), stereo (including joint stereo) and multi-channel (up to 5.1) audio decoding for:

- MPEG-4 HE AAC Level 4, version 1 with LATM/LOAS packing (ISO/IEC 14496-3) and
- Enhanced AC3 (“Dolby Digital Plus”) (ETSI TS 102 366) and
- MPEG-1 Layer II (ISO/IEC 11172-3), here only up to 2.0 stereo

5.2.2. 2-channel audio downmix

The IRD shall support 2-channel Downmix of both HE.AAC and Enhanced AC3 incoming multi-channel (up to 5.1) stream into a 2 channel output (stereo).

It shall not be required to use external audio (decoder) equipment, like audio home theatre system, for the MPEG4-services with multi-channel audio. External interfacing equipment (like TV display unit) shall not be required to support more than 2 channel PCM audio within main V/A interface (HDMI/SCART).

5.2.3. Audio settings from factory default

Factory default shall be that 2-channel down-mix of multi-channel audio for the Main output (HDMI and SCART for STB and internal speakers for iDTV).

5.2.4. Variable bitrate

The IRD shall support decoding of variable bitrate of HE.AAC (up to level 4) audio stream.

5.2.5. MPEG4 HE-AAC metadata

It is important that the IRD take care of the audio output loudness level due to differences between used audio codec and uses any metadata, so the listener will not experience significant differences in loudness from one service to another. For multichannel audio it is common that different content providers are broadcasting with different audio loudness levels out from the studio and to be able to compensate for this in the IRD side, the actual audio loudness level is normally signalised in the broadcast.

According with NorDig Unified’s chapter for metadata for HE-AAC (“system B”), the IRD shall support dynamic adjusting the audio loudness level accordingly with any MPEG4 HE-AAC metadata.

The IRD shall within 1 second adjust for any changes in the received audio metadata.

The adjustment of audio output level due to metadata information shall affect all decoded audio outputs.

This means for example that for two (HE-AAC) audio streams with the same content and which includes audio metadata, that are broadcasted with 6dB difference in dialogue loudness and the metadata describe the same 6dB difference in dialogue loudness, then the IRD shall output these two streams at approximately the same perceived audio loudness.

The IRD shall make use of all MPEG4 HE-AAC audio metadata as defined by NorDig Unified for the control of the audio decoding and processing, which refers to:

- program configuration (number of active audio tracks),
- basic audio output loudness level from (before any user volume control):
 - Program reference level (*similar as Dolby Dialogue Level/Dialogue normalisation/Dialnorm*),
 - Dynamic Range control (*similar as Dolby Line Mode Compression*) and
 - Compression value (*similar as Dolby RF Mode Compression*)
- downmix to stereo from:
 - MPEG4 ancillary data in audio elementary streams (Center mix value, Surround mix level value and Dolby surround mode, *similar as Dolby Center Downmix Level, Surround Downmix Level and Dolby Surround Mode*)

5.2.6. Supplementary audio

The IRD shall be able to select the correct audio type stream according to user preference settings. The IRD shall have a setting to select by default the audio stream with the audio type ‘undefined’ (also referred to as the “normal” audio) for a service which has several audio streams with different audio types for a selected language. The IRD should support setting other default audio types.

The factory default for an IRD shall be that the default audio stream selection is set to “normal” (‘undefined’) audio type.

Audio streams/PIDs with no ISO639 descriptor shall be treated as of undefined audio type and stereo.

Example: if a service carries one “normal” audio (with ISO639 type 0x00 ‘undefined’ and language Finnish) and one visual impaired audio (with ISO639 type 0x03 ‘visual impaired’ and language Finnish) and when the IRD is set to use the “normal” audio track it shall select the “normal” audio PID. If the IRD supports and is set to visual impaired mode, then it shall select the visual impaired audio PID in this example.

5.2.7. Dynamic changes in audio

As a clarification to NorDig Unified IRD Audio Applications requirements for handling of dynamic changes of audio component(s), the IRD shall during decoding of a service be able to dynamic handle changes in ISO 639 language code in all supported audio streams listed in the PMT of the service, i.e. not only the current selected audio stream (see also 8.2). This refers to that when another audio stream (PID) than the current selected one, change its language code and that language code has higher priority in the IRD user preference setting, the IRD shall within one second change to this audio stream and start decoding without user interaction.

Example: if a service that first has one “normal” audio stream (PID) and its language code is English and then the service is changed to have two “normal” audio streams (PIDs) where the previous audio stream (PID) continues with its language English and the new audio stream (PID) has language Finnish. A IRD which has in its user preference settings primary audio to Finnish, shall in this example first when the service has only one audio stream select and decode English audio stream (PID) and when the service is changed the IRD shall automatically within 1 second change audio stream and select the Finnish audio stream (PID). (“Normal” refers to ‘undefined’ audio type).

5.2.8. HDMI/SCART audio during digital audio output

The audio should not be silence in main V/A interface (HDMI/SCART for STB and internal speakers for iDTV) when outputting digital (surround) on digital audio interface (SPDIF) interfaces, i.e. it is recommended to continue outputting 2 channel PCM audio in parallel when outputting multi-channel audio (DTS/AC3/AAC/PCM) on the separate audio interface.

For IRDs with separate digital audio interface (SPDIF), the user shall be able to mute the audio in the main V/A interface HDMI/SCART for STB and internal speakers for iDTV) via the IRDs menu.

5.3. Teletext

5.3.1. Teletext streams out of synchronisation

The IRD shall be able to handle EBU Teletext streams where the PTS values are “out of synchronisation” compared to the service’s PCR values. “Out of synchronisation” refers to when the PTS value of the stream differ more than allowed compared to the service’s PCR values and when the IRD can no longer manage the decoding buffers for that stream.

When selecting a service with a PES stream that is “out of synchronisation”, the IRD shall be able to decode and output this “out of synchronisation” stream within 10 seconds. For PES streams that are “out of synchronisation it is best effort for the IRD regarding the synchronisation performance.

5.3.2. Teletext streams without PTS

Some of Teracom’s and Boxer’s TV services EBU Teletext streams are broadcasted with PTS (Presentation Time Stamp) and some others EBU Teletext are without PTS. EBU Teletext without PTS typically consists of both normal Teletext pages and subtitling pages. For EBU Teletext without PTS the broadcast is packetized as one PES packet per “frame” (ie in average every 40ms), while EBU Teletext streams with PTS may have other broadcast periods.

The IRD shall support decoding and presenting both EBU Teletext with PTS and EBU Teletext without PTS.

According with ETSI EN 300 472, IRDs *may* use the PTS to synchronise the decoding process (for EBU Teletext streams including PTS), but shall also be able to perform the decoding process before the maximum retention time of 40 ms is elapsed (for EBU Teletext streams without PTS).

The timing requirement (relative synchronisation or “lip sync”) for presenting the decoded EBU Teletext subtitling in the outgoing video during live TV viewing is ± 0.3 seconds (and ± 1 second for normal pages) relative when the EBU Teletext data have been broadcasted in the transport stream (including the buffer decoder model) and the service’s PCR. *Since the requirement is optional to use the PTS during the decoding process of EBU Teletext, the relative timing requirement for presenting the EBU Teletext are the same for streams with or without PTS.*

See 10.1.2.3 for PVR’s timing requirement for presenting the decoded EBU Teletext subtitling (with or without PTS) in the outgoing video during live playback.

6. Interfaces

This chapter covers the requirement defined for Interfaces and Signal Levels and refers to the NorDig Unified specification chapter 9.

6.1. HDMI and HDCP (NorDig chapter 9.9.4)

The HDCP must be on (enabled/activated) in the signal within the HDMI-link out of the IRD for services in case of any following alternatives:

- if any of service's components has copyright flag in TS/PES header is set on ('1') and/or
- if signalised as must be on via PSI/SI descriptor in PMT as specified in NorDig specification and/or
- if signalised as must be on via CA-system as specified in NorDig specification.

If any of the above alternatives request the HDCP must be on, then the service is here referred to as a 'protected' service.

Only if none of above alternatives signalise that the service must have the HDCP on, then the IRD may send out a signal without HDCP on and then the service is here referred to as an 'open' service.

(Signalised via CA-system refers to "control information" inside the ECM data of the service or in the EMM data).

It shall be possible to change user settings in the IRD for 'open' services if the HDCP shall be on (enabled) or off (disabled). (An IRD may send out signal with HDCP on (enabled) even for 'open' services, this for example to reduce zapping time between services and avoid re-negotiation of the HDMI-link between the devices).

6.2. Analogue HDTV: component YUV/YPbPr

Due to the current strict requirements of content protection for HDTV material and there is today still a lack of copy protection mechanism (like Macrovision) for the analogue HDTV signals (like 720p and 1080i), any analogue video output of the HDTV IRD shall be maximum 576 lines regardless of incoming video signal.

6.3. External interfaces and removable media

Clarification to NorDig Unified 14.2.7 Limitations in local storage, interfaces, extraction and removable media for recordings, IRD (even "non-PVR" IRDs) shall not be able to output protected content (video and/or audio signals) from incoming MPEG signals on any interface in any un-protected compressed format (exception for digital audio over SPDIF interface).

For more information regarding applicable requirements for local storage, external digital interfaces, removable media etc of compressed signals please contact Teracom or Boxer TV Access.

7. Service Information (SI)

This chapter covers the requirement defined for Service Information, and refers to the NorDig Unified specification chapter 12 and 13.

7.1. Additional requirements to NorDig Unified specification

7.1.1. Compressed SI and text strings

To achieve more efficient broadcast (save bandwidth) for SI in DVB-T2 multiplexes, lossless data compression may be used for some SI data (typically on text string data, CRIDs etc) and/or in some EITs use “copy from” linkage to other events. The methods for this are still under development and optimisation for Nordic languages. It will be based upon open and non-discriminating technology.

IRD not supporting this shall skip all this unknown data and not output any error messages for the viewer.

Compressed text string inside known DVB and NorDig descriptors will be signalled with that the first byte of the text string has a specific start code (0x1F or other non DVB allocated byte outside the range 0x00 to 0x15 and 0x20 to 0xFF). This lossless compression will typically be used for EIT schedule tables’ text string data. IRD not supporting needed de-compression shall ignore the complete text strings starting with such specific start code.

“Copy from” linkage refers to an event (e.g. rerun) that only include a linkage pointing to another event in current the broadcast from which the IRD should copy all the description from into the EPG for this event with this linkage. This “copy from” linkage may not be service bounded, i.e. it could be a linkage pointing to event(s) from another service within the network.

7.2. Clarifications to NorDig Unified specification (chapter 12)

Following clarification is applicable in the DTT network.

7.2.1. Unknown SI and non-supported character tables

Descriptors and other data structures that are currently undefined or unknown to the IRD shall be skipped and shall not cause any harm.

IRD not supporting needed de-compression of compressed text strings, shall ignore the complete text strings that starts with 0x1F or other non DVB allocated byte not within the range 0x00 to 0x15 and 0x20 to 0xFF.

IRD shall ignore/skip the complete text string that is using DVB character tables that the IRD does not support.

7.2.2. SI Identification coding

7.2.2.1. Original Network ID and Network ID

The DVB Identifiers for the DTT networks are as follows (according to ETSI ETR 162, today maintained at DVB home page):

DTT Network	Original_Network_ID	Network_ID	Country code
Denmark	0x20D0	colour C plan (0x3201 to 0x3300)	208 (0x0D0)
Finland	0x20F6	colour D plan (0x3301 to 0x3400)	246 (0x0F6)
Sweden	0x22F1	colour B plan (0x3101 to 0x3200)	752 (0x2F0)

Table 3 Original Network Id for Teracom Boxer approved IRDs

The IRD shall map the original network ids into the appropriate country in the OSD menus (for example together with NorDig Logical Channel descriptor).

Note: Within DVBs allocation (ETR162), there is normally an un-written code of practise for digital terrestrial networks that the original network id has been allocated by the DVB office to the value of 0x2000 plus the country's ISO 3166 Country code value. Which is true for almost all countries, as far as we know of, BUT with one exception; the Swedish DTT. For some reason this was not the case for the Swedish DTT original network id value (0x22F1), Sweden has the ISO3166 numeric country value 752 (0x2F0).

7.2.2.2. Preferred DVB Network

The IRD's *Preferred DVB network* shall be the transport streams with an original network id that corresponds to the country in the IRD's user preference setting (which normally the user sets during first time installation), see list of original network id per country in chapter above.

If there is no match between the IRD's user preference Country setting and available original network id, then one of the available original network id shall be assigned as the IRD's *Preferred DVB network* id. For example, if the user has set Germany in the IRD country setting, but the IRD can only receive signals from Sweden (original network id 0x22F1) and Denmark (original network id 0x20D0), then the IRD shall either ask the user which of the available country (translated from the original network id) to assign as *Preferred DVB network* or assign the original network id (Sweden or Denmark) from the signal with best signal quality as the *Preferred DVB network*.

7.2.2.3. Private data specifier values

For the used private data specifier values, the following applies in the DTT network (also according to the DVB SI code allocation, ETSI ETR 162, inserted and used as specified in DVB SI Guidelines);

- Boxer TV Access private_data_specifier value: **0x00000014** (Swedish Terrestrial TV)
- NorDig private_data_specifier value: **0x00000029**

7.2.3. Logical Channel Descriptor (in NIT)

The IRD shall support both NorDig Logical Channel Descriptors (LCD), version 1 and 2.

7.2.4. Parental rating descriptor (in EIT)

This descriptor is used to give a rating of programme based on age or other criteria and is used to prevent children from viewing unsuitable programmes. The prevention mechanism, blanking of video and muting of sound, shall be included within the manufacturer software and it should make use of 4 digits pin code to access and change settings.

The IRD should start/(stop) its prevention mechanism, blanking video and muting audio, within 1 second after reception of selected service's present (running) event information (EIT pf) containing parental rating higher/(lower) than its user settings (see also 10.1.2.2 for handling of parental rating during recording and playback). I.e. the IRD should continuous check the parental rating conditions for selected service and each time the user zaps into a new service. It is common that the IRD also informs the viewer that the program event contains unsuitable material.

Example: When the user setting in the IRD for the maturity level is set to 17 years and the present event (EIT pf) for the selected service includes a parental rating descriptor with (country code "SWE" and) rating "0x0F" (i.e. at least 18 years old content), the IRD shall blank the outgoing video (e.g. black frame) and mute the outgoing audio.

7.2.5. Country and Language Codes within PSI & SI

Preferably all (main) country codes in ISO 3166 and all Alpha-3 language codes in ISO 639 should be handled. Due to the quite large number of codes in these specifications, *Table 4* and *Table 5* specifies the minimum types of codes that shall be handled by the IRD including the recommended translations.

(The codes in ISO 3166 (Country codes) are all in capital letters, the codes in ISO 639 (Language codes) are all in lower-case letters and observe the capital vs lower case letter notation in the translations).

Country (in English)	ISO 3166 code	Translation to be used (to native)	Possible to select as user's preferred country
SWEDEN	SWE	Sverige	Mandatory
DENMARK	DNK	Danmark	Mandatory
FINLAND	FIN	Suomi	Mandatory
NORWAY	NOR	Norge	Mandatory

Table 4 ISO 3166, Country codes for Teracom Boxer approved IRDs

Language (in English)	ISO639 (639-2 or 639-3)	Translation to be used in DTT	Possible to select as user's preferred languages	Comments
	Code	To native		
Danish	dan	Dansk	mandatory	
English	eng	English	mandatory	
Finnish	fin	Suomi	mandatory	
Norwegian	nor	Norsk	mandatory	
Original language	qaa	Original (dan) Original (eng) Alkuperäinen (fin) Original (nor) Original (swe)	optional	See DVB SI spec ETSI 300468 Annex F for "original audio"
Swedish	swe	Svenska	mandatory	
Undefined	und	Udefinieret (dan) Undefined (eng) Määrittelemätön (fin) Undefined (nor) Odefinierat (swe)	optional	treated same as original language (qaa)

Table 5 ISO 639 (639-2 or 639-3), Language codes for Teracom Boxer approved IRDs

7.2.6. Text strings and fields size of the SI descriptors

The recommended maximum transmitted field sizes in the descriptors in the DTT network are stated in the Table 7 below. These values can be used as a guideline in the IRD implementation (and if the transmitted text strings are longer than below, the IRD could typically truncate after this value).

Name Field	Name Length	Comments
Network Name	24	
Service Provider Name	20	
Service Name	22	
Event Name	40	
Short Event Description	250	
Extended Event description	255	
Component Description	32	Typically used in the ESG and/or in the info banner
Application Name	32	(for IRD with DVB MHP v1.1)

Table 6 Descriptor field length used in the DTT

8. Receiver states and Navigator

This chapter covers the requirements defined for different receiver states and is only partly covered by the NorDig Unified specification (see NorDig Unified chapter 3.4.4, chapter 13 and 14).

8.1. Installation mode

Installation mode is defined as the state where the IRD is searching, scanning and installing new multiplexes (transport streams) and services that is possible to receive. During (first time) installation mode, the generic user preferences are normally set (like languages, country etc).

It shall be possible to perform an automatic or manual search at any time (see NorDig Unified chapter 3.4.4).

Upon first time installation or after a reset to factory mode, the IRD shall perform an automatic search through the whole supported frequency range.

8.2. (Normal TV viewing mode) Active mode

Active mode is defined as the state where the IRD normally operates on the received services. The IRD continuously demodulate tuned frequency and decode all video, audio and data components.

All received dynamic PSI and SI data (PMT, EIT, TDT/TOT, running status and CA mode) shall be processed within 1 second (see chapter 5 of this document).

Typical dynamic changes that the IRD shall be able to handle are (with in some cases some disturbance):

- New PID(s) (e.g. DVB subtitling) is attached to a service
- PID(s) for video and/or audio is changed for a service
- Change of language in the ISO 639 language descriptor in the PMT for an audio stream, see 5.2.7.
- Changes of running status and/or CA mode (working together with linkage to replacement)
- Updates in EIT, TOT/TDT

8.3. (Automatic) Update mode

Update mode is defined as when the IRD is able to apply changes in the received “quasi-static” SI data (i.e. SI that is normally stored in the flash memory for service navigations such as Original Network ID, Transport Stream ID, Network ID, Service name, Service ID, Logic Channel Number, RF centre frequency and RF mode etc). The update mode should not affect the basic video and audio (see chapter 5 of this document). The IRD shall at least enter into update mode once (one time) from the time it has been turned off until the time it has been turned on (i.e. during stand-by mode). (The update mode is allowed to be interrupted by the user). .

For example, the IRD shall in ‘update mode’ update for:

- new services within installed frequencies (multiplexes/transport streams)
- changes in service name, logical channel number and service provider name
- remove services that are permanently removed from transmitted SI within installed frequencies. The IRD shall not remove any service(s) automatically from the ‘visible’ service list without user confirmation (to avoid irritation). I.e. the IRD shall automatically inform the user when a service is permanently removed and ask for user confirmation to remove the service from the service list. Removed services that are defined as ‘non-visible’ shall be removed without user confirmation

For example, the IRD should in ‘update mode’:

- not overwrite any user preferences

The IRDs Service List shall be based on information from the SDTs. (The services listed in the NIT, e.g. in the NorDig Logic Channel Descriptor, might not be complete).

Updates that require actual tables (SDT actual and/or NIT actual) from another transport stream than the IRD is currently scanned to, should wait until the user select a service from a transport stream that contains the actual table(s) for this update.

8.4. Stand-by and power off mode

Stand-by mode is defined as when the IRD does not present any decoded components, like video and audio, on any of the IRD's outgoing connectors (RF loop through shall not be affected in this mode). The user shall be able to turn the IRD from Stand-by into Active mode. The IRD should have a minimum of power consumption during stand-by mode (typical 1W or less).

Power off mode is defined as the mode where the IRD is completely turned off.

8.5. User interfaces

8.5.1. Languages

The IRD shall support all menus available in at least Swedish, Danish, Finnish and English languages. The IRD should in addition also support all menus available in other Nordic languages.

9. Controller and Memory

This chapter covers the requirement defined for Controller and Memory, and refers to the NorDig Unified specification chapter 11.

9.1. Clarifications to NorDig Unified specifications (chapter 11)

An upgrade/replacement of the IRD's software is here referred to as System Software Update (SSU). If the SSU is via transmitting the new IRD's software over the broadcast channel it also referred to as Over-The-Air (OTA) download.

The IRD shall provide a mechanism to detect corrupt downloaded system software before it is used to replace the current working software. If the received system software is corrupt (refer to subclause 10.2 in NorDig Unified), the IRD shall keep the current (working) version of the system software, thus making the IRD operational again. If so, the failure to download shall be indicated to the user with an error message that can be used in the contact with the customer relations office. It shall be possible for the user to abort the download (in areas of bad reception quality the download may take too long time) and the IRD shall be operational using the current version of system software.

The IRD manufacturer shall provide the required MPEG-2 TS binary file (containing only the applicable SSU service and all its (PSI/SI) signalling necessary for successful upgrade) intended for cyclic broadcast for each new version intended for system software download. For each new version of system software over-the-air download, the manufacturer shall provide all necessary description documents to the network operator required for the transmission of the new software.

10. PVR requirement

10.1. General PVR requirement

This chapter covers the requirement defined for PVR (Personal Video Recording), and refers to the NorDig Unified specification chapter 12, 14 and 16, with the following clarifications and additional requirements..

IRD which includes PVR functionality (from here referred to as a PVR) shall support all mandatory PVR requirements listed in NorDig IRD specification with the following clarifications and additional requirements.

10.1.1. Optional NorDig requirements

Following NorDig PVR functions are optional to support:

- Trailer booking/promotional link and
- Broadcast Record List.

10.1.2. Additional requirements to NorDig Unified specification

Following NorDig optional PVR requirements (marked as ‘should’) are mandatory to support.

10.1.2.1. **Security for recordings (NorDig Unified 14.2.7)**

All types of recordable IRD (like PVRs) shall fulfil requirements stated in chapter 3.1.3 of this document and NorDig Unified’s limitations in local storage, interfaces, extraction and removable media for recordings (ch 14.2.7). For any conflict, this document’s security requirements have precedence before NorDig Unified security requirements.

10.1.2.2. **Full service recording and playback (NorDig Unified 14.3.9 and 14.4.5)**

The PVR shall be able to make *full service recordings* as described in NorDig Unified ch 14.3.9 including relevant parts of the service’s PSI/SI (PMT and EIT) information like parental rating, signal protection, copy protection etc. The PVR recording shall handle dynamic changes in the service’s PMT and EIT (EIT present section), regarding parental rating and changes in PMT (like change of PID values etc).

The PVR shall be able to make *full service playback* as described in NorDig Unified ch 14.4.5, with the meaning that during playback the PVR shall be able to set the same full service control as during live viewing, for example blanking of video and muting of sound depending on the event’s parental rating values, signal protection, changes in elementary streams (e.g. dynamic change of PID values).

10.1.2.3. **Recording and playback of Teletext without PTS**

See 5.3.2 for requirements of EBU Teletext without PTS during live TV viewing.

A PVR shall be able to handle recording and playback of services with Teletext without PTS. A PVR’s timing requirement (relative synchronisation or “lip sync”) during playback and resumed playback of Teletext components without PTS shall be almost the same as during live TV viewing, this refers to within ± 0.5 second compared to the components timing at the live broadcast occasion.

10.2. Boxer Navigator

IRD which supports Boxer Navigator PVR functionality (from here referred to as a Boxer Navigator PVR) shall comply with general PVR requirements listed in chapter 10.1 above (ie NorDig PVR) plus all the Boxer Navigator requirements stated in this chapter. (For any conflict, a Boxer Navigator requirement has precedence before a NorDig PVR requirement).

10.2.1. General about Boxer Navigator

Boxer Navigator refers to that a PVR supports an additional requirements related to recording, managements of recordings and advanced display of event information (EPG). Essential for a Boxer Navigator IRD is the capability of series recording, support of additional private event information (Boxer Navigator CBI data), search in EPG etc.

10.2.1.1. *Priority between CRIDs and Boxer Navigator CBI series data*

When indentifying a broadcast event or a recording, CRIDs shall have priority if both CRIDs and Boxer Navigator CBI series data is available (meaning that the PVR shall only use the CRID values for identification of the series and instance).

10.2.2. Boxer Navigator CBI data

The Boxer Navigator service is based on using the DVB standard EIT stream (PID 18, with some additional private data, see 10.2.2.1) and with the possibility of an additional stream of event information on another PID value, referred to as EIT+/EITplus (see 10.2.2.2). The EIT+ stream might includes event information for all service or only for some of the services within the Network. An EIT+ stream uses same basic table structure as the DVB standard EIT stream. An EIT+ stream is typically DVB scrambled with the Networks CA system.

The Boxer Navigator service also defines additional proprietary event information (ie a private descriptor, crex Boxer infotag descriptor, see 10.2.2.1) which includes information like actors, season, episode, series id etc. This additional event information may be broadcasted both in the standard EIT and in any EIT+ stream.

For the series recording there are two signalling mechanism, the newer NorDig alternative with DVB TV Anytime CRIDs (first priority) and the older Boxer Navigator Series_id (second priority). (The Boxer Navigator Series_id is included in the Crex Boxer infotag descriptor).

10.2.2.1. *Crex Boxer Infotag descriptor (CBI descriptor) in EIT*

The proprietary Crex Boxer Infotag (CBI) descriptor carries the additional private Boxer Navigator metadata (CBI data or Boxer Navigator CBI data).

One or multiple instances of the private Crex Boxer Infotag descriptor (CBI descriptor) may be used in the EIT (pf and schedule) descriptor loop. The CBI descriptor includes additional event information, to be presented for the PVR viewer and to be used for series recording.

Syntax	No. of bits	Identifier	Comments
crex_Boxer_infotag_descriptor(){			
descriptor_tag	8	uimsbf	
descriptor_length	8	uimsbf	
CBI_type	8	uimsbf	
if (CBI_type == 0x01){			
series_id	32	uimsbf	logic
episode	16	uimsbf	logic + GUI
episodes_total	16	uimsbf	GUI
season	16	uimsbf	logic + GUI
status	8	uimsbf	GUI
production_year	16	uimsbf	GUI
prod_country_length	8	uimsbf	
for (i=0;i< prod_country_Length;i++){			
prod_country_char	8	uimsbf	GUI
}			
spoken_lang_length	8	uimsbf	
for (i=0;i< spoken_lang_length;i++){			
spoken_lang_char	8	uimsbf	GUI
}			
director_length	8	uimsbf	
for (i=0;i< director_length;i++){			
director_char	8	uimsbf	GUI
}			
} /end CBI_type ==0x01/			
if (CBI_type == 0x02){			
for (i=0;i<N;i++){			
credit_type	8	uimsbf	
credit_length	8	uimsbf	
for (i=0;i< credit_length;i++){			
credit_name_char	8	uimsbf	GUI
}			
}			
} /end CBI_type ==0x02/			
if (CBI_type == 0x03){			
for (i=0;i<N;i++){			
keyword_type	8	uimsbf	
keyword_length	8	uimsbf	
for (i=0;i< keyword_length;i++){			
keyword_char	8	uimsbf	
}			
}			
} /end CBI_type ==0x03/			
}			

Table 7 Crex Boxer Infotag (CBI) descriptor

Logic refers to that the value is used for logic behind series recording (when using CBI descriptor). GUI refers to that the value is used for presenting information for the viewer in the GUI.

Semantics for the service list descriptor:

CBI_type: An 8 bit field specifying CBI (Crex Boxer Infotag) type, each CBI descriptor will only contain data of one CBI type. The CBI type is coded according to table below.

Value	Description
0x00	<i>reserved</i>
0x01	CBI Basic Info
0x02	CBI Credits
0x03	CBI Keywords
0x04-0xFF	<i>reserved for future use</i>

Series_id: This 32 bit field contain the unique identifier to the series this event belongs to. The series_id is only unique within a service (ie original_network_id, transport_stream_id and service_id). The SeriesID 0x00000000 represents that the event does not belong to any series. The Series_id is not intended to be human readable and shall not be displayed on-screen. The Series_id value may be reused for other series for that service after 91 days break since last time used (this means that the series_id shall not be re-used for any other series within this service for 91 days after the scheduled end-time of the last event that referenced this series_id).

Episode: This 16 bit field identifies the episode number (numeric value). The episode is used together with season to identify an instance within the series (logic) and may be displayed for the viewer together with other event information (GUI). Logic, even if an episode may be broadcasted over multiple instances (ie reruns), the PVR shall only record one instance/copy of each episode in a series (see 10.2.4.9). The Episode value 0x0000 represents that the event does not have any episode number and shall not be displayed for the viewer.

Episodes_total: This 16 bit field identifies the total numbers of episodes within a series (numeric value). The episode_total may be displayed for the viewer together with the episode and other event information (GUI), for example as “(<episode>/<episodes_total>)”. The Episode_total value 0x0000 represents that series belonging to the event does not have any total number of episodes and shall not be displayed for the viewer.

Season: This 16 bit field identifies the season of the series (numeric value). The season is used together with episode to identify an instance within the series and may be displayed for the viewer together with other event information (GUI). The Season value 0x0000 represents that the event does not have season information and shall not be displayed for the viewer.

Status: This 8 bit field identifies the status of this broadcasted event. The *status is live broadcast* and *is_rerun* may be displayed for the viewer together with other event information (GUI). Shall not be used to control any recordings (instead the episode and the season is used to identify an instance and avoid recording multiple instances of same content).

bit	Description	Comments
0	Is_live_broadcast (0: non-live, 1: Live)	GUI
1	Is_rerun (0: not re-run, 1: is a re-run)	GUI
2	<i>reserved for future use</i>	
3	<i>reserved for future use</i>	
4	<i>reserved for future use</i>	
5	<i>reserved for future use</i>	
6	<i>reserved for future use</i>	
7	<i>reserved for future use</i>	

Production_year: This 32 bit field identifies the production year of the series or episode. The Production_year may be displayed for the viewer together with other event information (GUI).

Prod_country_length, spoken_lang_length, director_length, credit_length and keyword_length: These 8 bit fields specifies the length in bytes of the following field.

Prod_country_char, spoken_lang_char, director_char, credit_char and keyword_char: These are an 8-bit fields. A string of char fields specify the item which may be displayed for the viewer together with other event information (GUI). Text information is coded using the character code table 5 (Latin/Turkish alphabet with Unicode equivalents) as described in DVB/ETSI EN 300 468 annex A, but without any character code table start code (0x05).

- The *prod_country* string represents the production country of the event.
- The *spoken_lang* string represents the spoken language of the event
- The *director* string represents the director for the event
- The *credit* string represents the credits like actors etc of the event
- The *keyword* string represents the keywords for the event, which typically may be used be the user to search or record all event with a specific keyword.

Credit_type: An 8 bit field specifying credit type and is coded according to table below.

Value	Description
0x00	Undefined type of Credit
0x01-0xFE	reserved for future use
0xFF	no more credit items in this CBI tag

Keyword_type: An 8 bit field specifying credit type and is coded according to table below.

Value	Description
0x00	Undefined type of Keyword
0x01-0xFE	reserved for future use
0xFF	no more keyword items in this CBI tag.

Example:

Descriptor_tag: Crex Boxer Infotag, 0xBC
 Descriptor_length: 40 bytes, 0x28
 CBI_type: CBI Basic Info, 0x01
 Series_id: 0xA7120810
 Episode: 10, 0x000A
 Episode_total: 30, 0x001E
 Season: 4, 0x0004
 Status: is a re-run, 0x02
 Production_year: '2006', 0x07D6
 Production_country_length: 7, 0x07
 Production_country: 'Sverige', 0x53766572696765
 Spoken_lang_length: no SpokenLanguage string is available, 0x00
 Director_length: 16 bytes, 0x10
 Director: 'Steven Spielberg', 0x53746576656E20537069656C62657267

Which results in total CBI descriptor string:

0xBC2801A7120810000A001E00040207D60753766572696765001053746576656E20537069656C62657267

10.2.2.2. **Boxer EIT+ stream**

An EIT+ stream uses same basic table structure and syntax as the DVB standard EIT stream, but contains normally more days of scheduled information and longer or more detailed description of included events. See chapter 10.2.3 for signalling of the EIT+ stream.

The DVB standard EIT streams includes event information for all services within the network, while the EIT+ stream might includes event information for all service or only for some of the services within the Network (this means that services that are included in the EIT+ stream are also included in the DVB standard EIT stream).

An EIT+ stream is typically DVB scrambled with the Network's CA system, while the basic DVB standards stream is unscrambled.

(A typical scenario could be that the DVB standard EIT streams contains full 8 days event information including extra Boxer private data for FTA services, while only 1 day of limited event information and with no extra Boxer private data for Pay-TV services. While the Boxer EIT+ streams contains full 8 days event information including extra Boxer private data for PayTV services, but do not include any event information for FTA services).

10.2.3. **Signalling for the Boxer EIT+ stream**

The Boxer EIT+ stream is using the same basic table structure and syntax as the DVB standard EIT tables and its descriptors including additional private description for the events (to describe for example episode, rerun etc). The Boxer EIT+ is broadcasted within the Swedish DTT network in parallel with the standard DVB EIT stream but on a non-DVB standard PID value (i.e. not PID 18) and is normally scrambled. The EIT+ stream is broadcasted within all DTT multiplexes (transport streams), enabling the IRD (receivers) to receive the EIT+ stream in the background at all time when decoding any of the TV services.

The Boxer EIT+ stream is signalled to from the DVB SI tables, inside the first loop of the NIT, using 'linkage to an EPG service' (0x02) with the private data as described in sub-chapter below. The private data inside the Linkage to the Boxer EIT+ includes an 'EIT+ identifier' value.

The Boxer EIT+ is identified in the Program Map Table (PMT) section for this service_id as a programme consisting of a private stream (stream_type 0x05) with a private descriptor, 'EIT+ identifier descriptor', that includes same 'EIT+ identifier' value as referenced from the NIT, and when scrambled this PMT section also includes one or more CA_descriptors to identify the associated CA streams.

(For the rest, the IRD shall follow the basic requirement within the NorDig Unified and DVB/ETSI specification TS101154, EN300468 and TR101211).

10.2.3.1. **Service_id and PID rules for the Boxer EIT+ stream**

Encoding: The service_id value 0xFFFF_{hex} (65535_{dec}) is reserved in DVB applications for this Boxer EIT+ purpose, (according with TR101211 chapter 4.1.4.2.2). The PID value for the Boxer EIT+ should be any non-DVB reserved value (i.e. between 32-8190_{dec}). (The standard DVB EIT stream's PID value shall still be 18_{dec}, according with the DVB SI specification). Only one Linkage to Boxer EIT+ may be used per NIT section (linkage to other EPGs may be used).

Decoding: The IRD supporting the Boxer EIT+ shall be able to handle any service_id and PID values that is used and referenced to for the Boxer EIT+ stream.

10.2.3.2. **Service type for the Boxer EIT+ stream**

Encoding: (If the Boxer EIT+ stream is broadcasted within a stand alone service) the service type for the Boxer EIT+ stream shall be set to a 'data broadcast service' (value 0x0C).

Decoding: The IRD supporting the Boxer EIT+ shall be able to handle any service type values that is used and referenced to for the Boxer EIT+ stream.

10.2.3.3. **Logical channel number for the Boxer EIT+ stream**

Encoding: The logical channel descriptor(s) for EIT+ service shall be set so that that service is not listed in the IRD's visible service_list and without logical channel number, i.e. non-visible (B listed) and logical channel number '0x0000'. (Applicable for NorDig Logical channel descriptor version 1, NorDig Logical channel descriptor version 2 and the old Senda/Boxer Channel List descriptor)

Decoding: The IRD supporting the Boxer EIT+ shall be able to handle any logical channel number for the service that carries the Boxer EIT+ stream.

10.2.3.4. **Stream type for the Boxer EIT+ stream**

Encoding: The stream type for the Boxer EIT+ shall be 'private_sections' (value 0x05)

Decoding: The IRD supporting the Boxer EIT+ shall be able to handle any stream type values that is used and referenced to for the Boxer EIT+ stream.

10.2.3.5. **Linkage descriptor for Linkage to Boxer EIT+**

The parameter linkage_type (under the linkage_descriptor) value 0x02 (EPG service) is reserved for the Linkage to Boxer EIT+ service use. Used in first loop of the NIT (actual).

Syntax	No. Of bits	Identifier
linkage_descriptor(){		
descriptor_tag	8	uimsbf
descriptor_length	8	uimsbf
transport_stream_id	16	uimsbf
original_network_id	16	uimsbf
service_id	16	uimsbf
linkage_type	8	uimsbf
for (i=0; i<N ;i++){		
EIT+_identifier	64	uimsbf
Broadcast_type	2	uimsbf
reserved	6	uimsbf
}		
}		

Table 8 Linkage descriptor for Boxer EIT+

Those identifiers not defined in EN 300 468 are specified below:

EIT+_identifier: This is a 64-bit field which identifies the "EPG" (EIT+). The value 0x000000004549542B ("EIT+") is reserved for the Boxer EIT+ stream.

Broadcast_type: This is a 2-bit field that describes the content of the Boxer EIT+ stream and IRD usage of the two event information streams; the standard DVB EIT stream and the Boxer EIT+ stream.

Broadcast type	Description
00	The Boxer EIT+ stream carries complete schedule data for all services within the network, but no present/following data. The standard DVB EIT p/f stream carries Boxer EIT+ private data. <i>The IRD supporting the Boxer EIT+ may replace the standard DVB EIT schedule stream (all EIT sch) with this Boxer EIT+ stream, but keep the DVB standard EIT p/f stream.</i>
01	The Boxer EIT+ stream carries complete schedule data for all services within the network including present/following data. <i>The IRD supporting the Boxer EIT+ may replace the complete standard DVB EIT stream (p/f and sch) with this Boxer EIT+ stream</i>
10	The Boxer EIT+ stream carries only additional schedule data for the services within the network (i.e. additional events compared to the standard DVB EIT sch stream and the Boxer EIT+ carries no present/following data). The standard DVB EIT p/f and sch stream carries Boxer EIT+ private data (i.e. here the Boxer EIT+ extends the length of schedule data). <i>The IRD supporting the Boxer EIT+ may the standard DVB EIT (p/f and sch) plus also use the Boxer EIT+ stream to extend the length of the EPG/(ESG).</i>
11	Reserved for future use.

reserved: reserved for future use. (IRD supporting this Boxer EIT+ shall neglect these bits value).

10.2.3.6. **Boxer Private descriptor; EIT+ identifier descriptor**

The private descriptor identifying the EIT+ stream. Used in the PMT section of the service that carries the Boxer EIT+ stream.

Syntax	No. Of bits	Identifier
EIT+_identifier_descriptor(){		
descriptor_tag	8	uimsbf
descriptor_length	8	uimsbf
EIT+ identifier	64	uimsbf
}		

Table 9 Boxer EIT+ identifier descriptor

Descriptor_tag: 0xBA

EIT+_identifier: This is a 64-bit field which identifies the EIT+. The value 0x000000004549542B (“EIT+”) is reserved for the Boxer EIT+ stream.

10.2.4. **Boxer Navigator PVR requirements**

The Boxer Navigator PVR shall support same PVR requirements via Boxer Navigator CBI data as via CRIDs as described in NorDig Unified specification Series recording (and in chapters below), with following exceptions:

- Boxer Navigator CBI is limited to only be within one service. This means that series recordings and split recordings are limited to only be within one service . (A service refers to the MPEG triplet original_network_id, transport_stream_id and service_id).
- Boxer Navigator has no requirements for Recommended events via Boxer Navigator CBI data (ie only requirements recommended event via using CRIDs)

10.2.4.1. **EIT+ and priority between EIT+ and EIT**

A Boxer Navigator IRD shall support both DVB standard EIT and Boxer EIT+ stream (see chapter 10.2.3).

A Boxer Navigator IRD shall support both that the EIT+ stream might be unscrambled or DVB CSA scrambled (with the networks defined CA System).

A Boxer Navigator IRD shall use the event information from the EIT+ stream for those services that are included in the EIT+ stream and for those services that are not included in the EIT+ broadcast an IRD shall use the DVB standard EIT stream.

10.2.4.2. **Boxer Navigator private descriptor**

A Boxer Navigator IRD shall support private descriptor crex Boxer_infotag_descriptor, as defined in 10.2.2.1.

10.2.4.3. **Identification of a Boxer Navigator series and programme instance**

A Series signalled via Boxer Navigator Crex Boxer Infotag (CBI) data shall be identified via following values together (giving a similar representation as DVB/TV Anytime series CRID):

```
<original_network_id>.[<transport_stream_id>].<service_id>;<series_id>
```

An Instance within a Series signalled via Boxer Navigator CBI data shall be identified via following values together (giving a similar representation as DVB/TV Anytime programme CRID):

```
<original_network_id>.[<transport_stream_id>].<service_id>;<series_id>.<season>.<episode>
```

Informative, a Series signalled via CRID is identified via Series CRID and a instance/programme/episode signalled via CRID is identified via Programme CRID.

10.2.4.4. **Complete recordings and full service recording**

The Boxer Navigator PVR shall treat recordings where the whole duration of the programme (including any split recordings) has successfully been recorded as *complete recordings*. Programmes that where only partial duration of the programme/event has been recorded shall be treated as *incomplete recordings*.

The Boxer Navigator PVR shall be able to make *full service recordings*, which refers to recordings shall (factory default) include all supported components/PIDs listed in the PMT of the recorded service (e.g. video, audio 1, audio 2, Teletext, DVB subtitling, PCR etc).

10.2.4.5. **Record data list**

The Boxer Navigator PVR shall keep track of the data about the recordings, which shall among other things include information for:

- Future active scheduled recordings (both manual and series). For each active booked series the PVR shall (except storing series CRIDs and CBI series_id and other data) also store information booking time (when user has programmed a series to be recorded) and start_time for last received event

carrying the applicable series (series CRID and CBI series_id). This among other things to be able to handle conflicts, series recording and re-use of series (series CRID and CBI series_id) see 10.2.4.8 and NorDig Unified.

- List of recordings. Acquired and current stored recordings that are (or will be) accessible for playback (both manual and series). For recordings including CRIDs and/or CBI series_id the PVR shall (besides other information) also store information about the instance (CRIDs and for Boxer CBI see 10.2.4.3), start_time of the recording and if the recording has been complete or not. This among other things to be able to handle record only one instance per episode (see 10.2.4.9).
- List of recently removed series recordings. For recently removed (deleted) recordings that did including CRIDs and/or CBI series_id and that were complete recordings, the PVR shall store instance information (CRIDs and for Boxer CBI see 10.2.4.3) and recorded start_time or deletion time of the recording up to 91 days from its start_time or 31 days from its deletion time (whatever occurs last of these two). For removal/deletion of incomplete recordings, the PVR shall not store any information within the list of recently removed series recordings. Deletion of recordings without CRIDs and with CBI data where series_id value 0x00000000 or episode value 0x0000 shall not be included as recently removed recordings. This among other things to be able to handle not re-acquiring a recently deleted recording (see 10.2.4.10). Any list of recently removed recording is not intended to be displayed for the user.

10.2.4.6. **Signalling alternatives for series**

A Boxer Navigator PVR shall support both alternatives for signalling series (DVB TVAnytime CRIDs and Boxer Navigator Series_id).

For events/series including both alternatives, the Boxer Navigator PVR shall use the DVB TVAnytime CRIDs. The requirement for priority of the DVB TVAnytime CRIDs compared to the Boxer_infotag series_id refers to the time when the user is programming the IRD, (ie if the broadcast at the time of programming the IRD to record a specific series only contains Boxer_infotag series_id, and while this series is active in the IRD for series recording and it later on for this series contains both DVB TVAnytime CRIDs and Boxer_infotag series_id, the IRD may still use Boxer_infotag series_id).

10.2.4.7. **Series recording via CRIDs (NorDig Unified 14.3.3)**

The default authority may be changed over time (for example a service might have default authority added in SDT), the Boxer Navigator PVR shall automatically update its stored default authorities (within 15min after reception).

10.2.4.8. **Series recording via Boxer Navigator Series_id**

The Boxer Navigator PVR shall support same requirements for Series Recording via Boxer Navigator Series_id as via CRIDs as described in NorDig Unified specification Series Recording, except that Boxer Navigator is limited to only be within one service (service refers to the MPEG triplet original_network_id, transport_stream_id and service_id).

All events within a service that have the same Boxer Navigator Series_id belongs to the same Series. (observe that Boxer Navigator Series_id is only unique within a service, while CRIDs (incl any default authority) is unique cross all services).

The Boxer Navigator PVR shall be able to record a complete Series via the CRID and Boxer Navigator Series_id.

The Boxer Navigator PVR shall store and track Boxer Navigator Series_id for each service (see 10.2.4.3 for id of a series) that are programmed for recording for up to 91 days between occurrences in EIT schedule. To allow broadcasters to reuse a series CRID for a different editorial concept, the Boxer Navigator PVR shall

discard any series recording with Boxer Navigator Series_id for a service that has not been seen in EIT for 91 days.

10.2.4.9. **Series recording, only one instance/copy of each episode** (NorDig Unified 14.3.3.3)

The Boxer Navigator PVR shall support (both for CRIDs and for Boxer Navigator Series_id) the feature to only record one instance/copy of each episode in a series for series recording (to handle re-runs). (The Crex Boxer Infotag values ‘season’ together with ‘episode’ shall be used to identify an instance within a series for a service, see 10.2.4.3).

This means that before recording a programme the PVR shall check if a complete recording of the programme already exists in its list of recordings or recently removed recordings, identified via match of programme CRID or CBI instance identification see 10.2.4.3. If a complete recording of programme already exists in the lists, the PVR shall not record the programme/event.

If only an incomplete recording or no recording of this programme exists, the PVR shall record the programme/event. A new recording with the same programme content than an earlier incomplete recording, shall replace the incomplete recording in the PVR (without any user interaction and the incomplete recording shall be deleted).

Exception, for events without programme CRID but with CBI data where series_id value 0x00000000 or episode values 0x0000, the events shall be recorded even if an instance with same programme CBI instance identification can be found in the record list. (For instance identification see 10.2.4.3). (Observe that for event with both CRIDs and CBI data, the CRIDs has priority and shall be used for identifying the instance and the CBI data shall only be used for presenting additional information of the event, like episode number, credits etc).

When the viewer/user during the time of manual programming a recording (booking) is selecting an event that is already recorded in the list of recordings (identified via match of programme CRID or CBI instance identification see 10.2.4.3), the Boxer Navigator PVR shall prompt the viewer event has already been recorded and ask for confirmation to anyway book the recording (ie if viewer confirms re-acquire the content, the Boxer Navigator PVR shall be able to record the event).

10.2.4.10. **Recording of recently removed recordings**

Recently removed recordings are recordings that included CRIDs or CBI series data and that have been deleted and there has not passed 91 days from its recorded start_time or 31 days from its deletion time (whatever occurs last of these two).

For already booked series recordings, The Boxer Navigator PVR should not re-acquire recently removed recordings (identified via match of programme CRID or CBI instance identification see 10.2.4.3). After the time has passed for the recently removed recording, the Boxer Navigator PVR shall re-acquire the event.

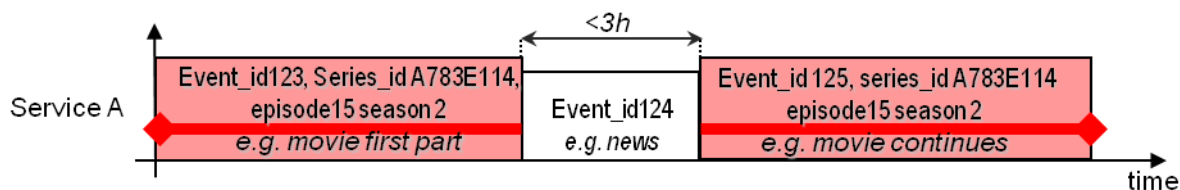
When the viewer/user during programming a recording, ie making a booking, (manual or series) and viewer/user selects an event or series within the received EIT data which contain an event that is a recently deleted recording (identified via match of programme CRID or CBI instance identification see 10.2.4.3), the Boxer Navigator PVR shall prompt the viewer that the event has been recorded and recently deleted by the user and ask for confirmation to continue booking it for recording (ie if viewer confirms re-acquire the content, the Boxer Navigator PVR shall be able to record the event).

10.2.4.11. **Split recordings via Boxer navigator CBI**

The Boxer Navigator PVR shall support split recording (both for CRIDs and for Boxer CBI data) as described in NorDig Unified (ch 14.3.4).

The Boxer Navigator CBI data does not include any IMI extension. A “split programme” via Boxer Navigator CBI data is a single piece of content which comprises of two or more EIT events for the same

service having the same series_id, episode and season values with the gap from the scheduled end time (start_time plus duration) to the scheduled start time of any two of those events is less than 3 hours.



The Boxer Navigator PVR shall consider a split programme via Boxer Navigator CBI to be segments of a single item of content. When selecting a split programme for recording, the Boxer Navigator PVR shall select and record all constituent events so that the complete programme content is recorded.

(Clarification, for a CRID based split recording alternative it is enough via using the programme CRID value while for Boxer Navigator CBI based alternative has to use original_network_id, transport_stream_id, service_id, series_id, season and episode, see 10.2.4.3 for identification of an instance).

10.2.4.12. **Alternative instance via Boxer Navigator CBI data**

The Boxer Navigator PVR should in addition to use DVB/TV Anytime CRID (NorDig Unified ch 14.3.5) also be able to use Boxer Navigator CBI data to identify more instances of the programme in the EIT data, this to be used for the alternative instance recording. (To identify and instance via Boxer Navigator CBI data see 10.2.4.3).

10.2.4.13. **One touch recording of series** (NorDig 14.3.15)

A Boxer Navigator IRD shall support One Touch Recording (OTR) as specified in NorDig Unified chapter 14.3.15, meaning record remaining part of present event (single event and no series recording).

It should be possible to configure (in user preference settings) the OTR in two different modes:

- Direct record remaining part of present event (including any late catch-up caching) without any further user interaction (single event and no series recording) as specified in NorDig Unified chapter 14.3.15.
- Asking for user confirmation whether the direct recording shall be;
 - present event (remaining part of present event (including any late catch-up caching), single event recording),
 - series recording (only if the present event belongs to a series) or
 - a pre-set time

The mode “asking for user confirmation” shall be factory default alternative.

10.2.4.14. **Safe margins, additional requirements** (NorDig Unified 14.2.9)

A Boxer Navigator PVR shall have a factory default setting of safe margins is activated and with margin values of 1 min before the event's start_time and 5 min after the event is no longer present. The margin before the event's start_time shall be based on latest possible EIT update (ie if the PVR receives an EIT update reasonable time before this safe margin time of that the event is delayed/postponed, the PVR shall take that in account). For recordings with safe margins, the PVR should insert indexes into the recording when the event becomes present/running and another when it becomes no longer present/not_running.

It shall be possible to de-activate safe margins.

Factory default shall be that this safe margins has lower priority than any back-to-back recording (see NorDig Unified 14.3.11 Back-to-back recording). (Observe that the PVR shall only remove safe margins when the PVR has limitations in recording capacity, if the PVR does not have any limitation the PVR shall keep the safe margins).

10.2.4.15. **Automatic conflict handling** (NorDig Unified 14.3.16)

The Boxer Navigator PVR shall have following factory default Priority list of handling recording conflicts. It should be possible to change the priority list within the PVR.

Priority	Recording type
1 (high)	Manual time based single recordings
2	Manual time based repeated recordings
3	Individual event recording (single shot)
4	Other recordings without alternative instance

Table.X Priority list for PVR. The alternative instance refers to when the IRD can detect an alternative instance of the programme within broadcasted EIT data before the programme starts.

It should be possible for the user to see and modify the relative priority between all active series recordings and automatic metadata triggered recordings.

The factory default relative priority between objects within same priority level shall be determined by the time of booking/creation (earliest booked/programmed scheduled shall have highest priority).

Any recording that may only be partially recorded (incomplete) due to overlapping of other recordings (including late over-run) shall be recorded anyway (see NorDig Unified 14.2.4 Failed and incomplete recordings).

10.2.4.16. **Display of Boxer Navigator CBI data**

The Boxer Navigator PVR shall be able to display in EPG when highlighting a specific event following Boxer Navigator CBI data (if they are present in the EIT broadcast):

- Episode and Episodes_total (for examples displayed as “(<episode>/<episodes_total>)” or “<episode>(<episodes_total>)”).
- Season

The Boxer Navigator PVR should also be able to display in EPG when highlighting a specific event following Boxer Navigator CBI data (if they are present in the EIT broadcast):

- Production year
- Credits
- Production country
- Spoken language
- Director
- Status

The Boxer Navigator PVR shall not display any empty CBI data values (ie where the value is zero/empty), see 10.2.2.1.

The Boxer Navigator PVR shall not in GUI following Boxer Navigator CBI data (if they are present in the EIT broadcast):

- Series_id
- Keywords (may be displayed when searching for keywords in the EPG search)

10.2.4.17. **EPG Search functionality**

The Boxer Navigator PVR shall include a function for the user to search inside the EPG.

The search function shall include means for entering a text string and execute a search for events within the available EPG data that matches the entered text string.

The search function should include options for more advanced search options, such as:

- Matching principle: The user can select to perform the search/matching according to either of the following principles:
 - o Search/match the entered text string only against (any part of) the event name as available from short_event_descriptor (default)
 - o Search/match the entered text string against (any part of) event name or event description as available from short_event_descriptor and extended_event_descriptor
- Genre: The user can select to restrict the search/matching to events within a specific genre (selectable according to content nibble levels 1 and 2). Default: no restriction.
- Channel: The user can select to restrict the search/matching to events within a specific channel (selectable among service names from IRD's service list). Default: no restriction.
- Days: The user can select which weekdays to include in the search:
 - o All (default)
 - o Monday to Friday
 - o Saturday to Sunday
 - o Single weekday (selectable Monday to Sunday)
- Time: The user can restrict the search to be applied only for a limited time interval during the selected days. Selectable start time and stop time. Default: no time restriction

It shall be possible for the user to perform a simple search without entering any advanced search option according to above. In this case the default options according to above shall be applied in the search.

The search results shall be presented in list form.

It shall be possible for the user to:

- Select to sort the search result list alphabetically or chronologically (default)
- Select to record one or more items in the search result list

10.2.4.18. **Presentation and management of future scheduled recordings**

The Boxer Navigator PVR shall at all time keep track of the future scheduled recordings.

The Boxer Navigator PVR shall be able to present for the viewer all scheduled recordings (manual single, manual repeated, series recordings).

For scheduled series recording the Boxer Navigator PVR shall have a view to present for the viewer each series recording as one entry/item among scheduled recordings. In addition the Boxer Navigator PVR shall have a view to present for the viewer all future scheduled events/episodes of the series that can be detected from the current EIT data. The future scheduled episodes should include information about when they will be available.

For presenting one series recording as one item, the event_name should be used. (The series name in the list does not have to be updated if the events' event_name in the series is not identical to each others).

The Boxer Navigator PVR shall in the EPG highlight events that are scheduled for recordings.

The user shall be able to delete any future scheduled recording. The user shall be able to delete one individual scheduled recording/event belonging to a scheduled series of the PVR, without deleting the schedule of the series.

The user should be able to change the relative priority between the active scheduled recordings (affecting the conflict handling, see 10.2.4.15).

10.2.4.19. **Presentation and management of acquired recordings** (NorDig Unified 14.2.1)

In additions to NorDig Unified requirements (14.2.1), the user shall be able to view a list of acquired recordings where all episodes of a series are grouped into same item in the list. Series items including several episodes should be marked (e.g. as series or similar) for the viewer that the item includes several episodes/recordings. Each such item (representing a group of recorded series episodes) shall be expandable on request by the user, so that all recorded episodes of that specific series are displayed.

The Boxer Navigator PVR shall in its presentation of list of recordings display information about the item's description taken from the EIT (preferably all EIT data for the event, like short and extended description, etc). The description of the event (preferably from the EIT p/f data) could typically be presented when highlighting the recorded item in the list of recordings.

10.2.4.20. **Resumed Playback and insertion of index** (NorDig 14.4.6)

The Boxer Navigator PVR shall support resume playback as described in NorDig Unified (ch 14.4.6).

10.2.4.21. **Cache in background and storage of EIT data**

Typical broadcast today of EIT data is 8day and common is that networks have faster repetition for the first day EIT data than for the last day. The broadcast (cycling time) of this EIT can become fairly long, especially for the events last day in the broadcast (up to 10 min or longer).

To speed up the presentation of EPG, the Boxer Navigator PVR shall support during normal TV viewing mode monitor and cache all EIT and EIT+ section data (p/f and schedule, actual and other tables) in the background at least from the same MPEG transport stream as the current live viewing service. The Boxer Navigator PVR shall updated its cached EIT and EIT+ data for any changes in the EIT and EIT+ broadcast (for example via monitoring changes in the version_number of the sections).

To speed up the presentation of EPG after start-up, the Boxer Navigator PVR should store the latest cache EIT and EIT+ data into the PVR persistent memory (e.g. hard drive).

10.2.5. **Example EIT broadcast regarding CBI and CRID**

Below is an example of how the Boxer Navigator PVR shall interpret the instance/programme, the series and the Episode and Season values out from the broadcast.

Broadcast, example with 5 events for one service:

	1.	2.	3.	4.	5.
	Event 1234	Event 1235	Event 1237	Event 1247	Event 2841
	CBI	CRIDs	CBI	CRIDs	CRIDs
ONID 8945	series_id a756	p.CRID: like.tv/big#1	series_id a756	p.CRID: like.tv/big#1	p.CRID: like.tv/muppetshow123
TSID 3	episode 13	s.CRID: like.tv/movies	episode 13	s.CRID: like.tv/movies	s.CRID: like.tv/muppetshow
SID 1010	season 2	CBI	season 2	CBI	s.CRID: like.tv/comedy
		series_id 0		series_id 0	CBI
		episode 0		episode 0	series_id b452
		season 0		season 0	episode 8
					season 12

A Boxer Navigator PVR interpretation of this broadcast example:

Instance/programme:

1. 8945.3.1010.a756.13.2
2. like.tv/big
3. 8945.3.1010.a756.13.2 either split recording or re-run
4. like.tv/big split recording
5. like.tv/muppetshow12

Series:

1. 8945.3.1010.a756
2. like.tv/movies
3. 8945.3.1010.a756.13.2
4. like.tv/movies
5. like.tv/muppetshow event belongs to 2 series
5. like.tv/comedy

Season and episode info (GUI):

1. s2 e13
2. -
3. s2 e13
4. -
5. s12 e8

ONID original network id, TSID transport stream id, SID service id, CBI CREX Boxer Infotag, p.CRID programme CRID, s.CRID series CRID